DOWNHOLE FLOW MEASUREMENT IN A WELL

BACKGROUND OF THE INVENTION

The invention relates to a method for downhole flow measurement in a well.

Such a method is known from International patent application WO 01/75403. In the known method one or more cold spots are created in a well tubing by injecting nitrogen into the well and expanding the nitrogen at selected downhole cooling stations.

A fibre optical cable extends in longitudinal direction through the well and is configured as a distributed temperature sensor ("DTS"), wherein one or more light pulses are transmitted through the fibre optical cable and the temperature pattern along the length of the cable is determined on the basis of determination of the intensity of Raman peaks in the backscattered optical signal. In a DTS system the time of flight of the backscattered signal is used to determine the location from where the signal is backscattered in a manner similar to the operation of a radar system.

In the known method the DTS system measures the speed at which the cold spot imposed at each cooling station migrates in downstream direction through the production tubing.

A disadvantage of the known method is that the installation of one or more cooling stations and a nitrogen or other cooling fluid supply line in a well is expensive and fragile and thus prone to damage.

It is an object of the present invention to provide a method of downhole flow measurement in a well, which does

not require the installation of one or more cooling stations and fragile cooling fluid supply conduits downhole in the well.

It is a further object of the invention to provide a method for measuring the influx of fluids into the well along at least part of an inflow region along which fluids flow from the surrounding formation into the well.

SUMMARY OF THE INVENTION

The method according to the invention for downhole flow measurement in a well comprises installing a fibre optical distributed temperature sensor (DTS) system along at least part of the length of an inflow region of the well and using the sensor to measure one or more fluctuations of the temperature of fluids flowing from the formation into the well and the velocity at which at least one of said natural fluctuations migrates in downstream direction through the well.

It has surprisingly been found that there are fluctuations of the temperature of the fluids that flow into the well, which fluctuations generally die out before the produced fluids have reached the wellhead. The temperature fluctuations are generally small and may be less than 1 Degree Celsius.

Accordingly it is preferred that the DTS system is configured to track the downstream migration through the well of low frequency temperature fluctuations of less than 1 Degree Celsius, typically fluctuations between 0.1 and 0.5 Degrees Celsius.

It is also preferred that the DTS system extends along at least a substantial part of the length of an inflow region of the well and that the method is used to assess the fluid inflow rate at different locations along the length of the inflow region on the basis of measured

variations of the velocity of the fluids in a longitudinal direction along at least part of the length of said inflow region. A stationary flowrate of fluids in downstream direction along a DTS measurement interval will generally indicate that no fluid flows into the measurement interval, whereas an increased flowrate in downstream direction along a DTS measurement interval will generally indicate that fluids flow from the formation into the well along the length of the measurement interval.

The method according to the invention may be applied to monitor the fluid flow rate and inflow rate downhole in a hydrocarbon fluid production well.

The fluids flowing into the well may comprise gaseous components, such as natural gas, and/or components which at least partly evaporate in the inflow region. In such case the fluid production rate of the well may be cyclically varied over time to impose temperature fluctuations caused by variation of the expansion and/or evaporation rate of the gaseous and/or evaporating fluids. In such case the fluid production rate of the well may be cyclically varied by cyclic variation of the opening of a production choke or downhole valve or by initiating a slug flow regime in the well or in the production flowline and/or processing equipment downstream of the wellhead.

These and other features, embodiments and advantages of the downhole flow monitoring method according to the invention are described in the accompanying claims and abstract.